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SPARES ACQUISITION INTEGRATED WITH PRODUCTION AND ITS INFLUENCE ON THE OBSOLESCENCE OF SPARE PARTS

Robert J. Arthur, GS-12
Ottis L. Fisher, GS-09

LSSR 34-80

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This thesis effort was directed toward the evaluation of the impact of ordering utilizing a program entitled Spares Acquisition Integrated with Production (SAIP). From the universe of all spares ordered in support of the A-10 aircraft program two populations were selected. The two populations consisted of spares ordered utilizing SAIP procedures and spares ordered utilizing non-SAIP procedures. From these populations two samples consisting of thirty-five part numbers each were randomly selected. A check was then made to determine how many approved Engineering Change Proposals (ECPs) each part number reflected. ECPs were determined to be a valid measure of obsolescence. A Mann-Whitney U test was then performed to determine if there was a significant difference between the number of approved ECPs processed against spares ordered utilizing SAIP procedures when compared to approved ECPs processed against spares ordered utilizing non-SAIP procedures. No significant difference was found.

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SPARES ACQUISITION INTEGRATED WITH PRODUCTION AND ITS INFLUENCE ON THE OBSOLESCENCE OF SPARE PARTS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

Robert J. Arthur, BS
GS-12

Ottis L. Fisher, BS
GS-09

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This thesis, written by

Mr. Robert J. Arthur

and

Mr. Ottis L. Fisher

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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CHAPTER I

INTRODUCTION

Overview

Historically, initial provisioning for a weapon system has been accomplished with the purpose of acquiring spare parts in advance of receipt of the operationally deployed weapon system or subsystem. Within the provisioning framework, initial spare parts were to be procured in minimum quantities only. Very high cost items (exceeding a $10,000 unit price) were not to be initially acquired. Contracting for these high cost spares was deferred until production phase-out of the end item, or until there was a demand for the item. Exceptions to the preceding were to be permitted on an item-by-item basis by departmental or agency level approval.

On a selective basis and with full documentation confirming the economic justification, production phase-out contracting for the life of operating programs could be authorized at the end of a production run for those support items where it would be economically impractical to reestablish a limited production capability (15:7).

Initial provisioning was viewed as an attempt to achieve maximum initial support utilizing available resources to acquire initial spares and repair parts with

emphasis on reduction of supply response time to allow a minimum but adequate range and depth of spares stockage. All acquisition programs were to consider the design stability of a system and its impact on logistic costs and risks as well as operational factors in planning the initial phase-in of operation capability and logistic support (13:1-1).

When the acquisition of the weapon system or subsystem was scheduled to extend over more than one fiscal year, only initial spares requirements related to the end items already on contract and scheduled for delivery within the item support period would be computed and ordered.

The Air Force, in an attempt to accomplish spares acquisition as economically as possible, developed the Spares Acquisition Integrated with Production (SAIP) concept. The intent of SAIP is to incorporate procedures that will save dollars by streamlining spares acquisition in an effort to reduce the acquisition costs of spare parts and production installed units, i.e., parts and subassemblies the prime contractor buys or manufactures to install on the end items that are being fabricated. This is accomplished through volume buying to take advantage of quantity discounts, aligning production installed unit and spare orders to reduce administrative costs, and to insure

interchangeability between production units and spare units (16:1).

Detractors of the SAIP concept indicate that there is a higher potential for obsolescence which is caused by ordering spares too early and in larger quantities. This research addressed the question of whether or not there was a higher incidence of obsolescence when using SAIP procedures.

Background

The initial support period is concerned with providing adequate spare and repair parts to support deliveries of equipment which occur during production lead time plus three months past the delivery of the operational weapon system or subsystem (17:1). Initial requirements are limited to new items identified during an acquisition or modification effort. When production begins, the flow of provisioning documentation begins, from which the Air Force makes its final decision on maintenance levels and factors, and ultimately computes and orders the initial spares quantities (13:1-1).

Provisioning actions and decisions are scheduled in advance of the weapon system deliveries in such a manner that the timely delivery of items is accomplished for initial support. On complex weapon system programs, a method of incremental release of procurement orders for

support items is followed so that the commitment/obligation of funds is based on the procurement lead time that will insure receipt of spares prior to the receipt of the weapon system or subsystem (15:7).

One problem with this procedure for ordering initial spares is that it offers no opportunity for cost savings by negotiating the spares prices at the same time as the weapon system or subsystem. It was recognized that if a procedure was developed for ordering spares at the same time that the prime contractor ordered his units for production, there could be an opportunity for quantity discounts and price breaks. The SAIP program has evolved to take advantage of this economy of scale (9).

The objective of the SAIP program is to reduce the cost of initial and replenishment spare/repair parts by ordering the spare/repair parts concurrently with identical production installed units. The SAIP program also strives for compatibility of spares and items installed during production, i.e., the spare and the installed unit must be identical (16:1).

Identical spares and production installed units do not mean that all items acquired throughout the entire production phase must be identical. The production phase may last for many years. Due to budget constraints, spares and production installed units are normally ordered on an annual basis. The spares and production installed

units of concern in this research effort were those that were purchased during a particular budget period.

During any particular budget period, engineering changes may be approved that affect the form, fit or function of a spare or production installed part. Once the engineering change has been approved, production installed units and spares to support the units in production must be configured with those approved changes incorporated (6).

Statement of the Problem

Concurrent ordering and manufacturing of spare parts and production installed parts under the SAIP program may increase the potential of acquiring and/or stocking obsolete spare parts. The potential problem arises because when aligning the spares orders with the prime contractor's production installs orders, the spares are ordered in an earlier phase of the production schedule and in larger quantities than would be the case if the SAIP procedures were not used. There may be design changes that affect the production installs and the spares after a commitment has been made to purchase earlier configured spares. Although design changes in later models can be expected, the chance of acquiring and stocking obsolete spare parts may be increased because of buying earlier and in larger quantities.

Implicit in the preceding statement is a trade-off consideration that must be made between the benefits to be derived from a reduction in unit price through volume buying and the cost of carrying extra inventory which has a higher risk of obsolescence.

Spare parts ordered under SAIP procedures should be design stable parts so as to minimize the risk of obsolescence (16:1). If a spare part is not design stable, it should not be considered for ordering under SAIP procedures.

This research effort did not deal with the costs associated with using the SAIP procedures, only the problem of an increased risk of obsolescence caused by ordering spares earlier with SAIP procedures and in larger quantities was addressed.

Research Objective

The objective of this research was to determine if there was an increased incidence of obsolescence on parts ordered under SAIP procedures when compared with parts ordered not using SAIP procedures.

Research Question

How does the SAIP concept affect the incidence of obsolescence?

Justification

The SAIP concept was conceived and is being promoted because its designers consider it a breakthrough toward benefits to be derived from buying design stable spare parts. This research investigated the potential problem of obsolescence caused by buying spares, which were subject to design changes, in advance of need and buying in volume to bring acquisition in line with a particular production effort.

Summary

The normal method of procuring spares prior to the SAIP concept usually meant placing a spares order and negotiating the prices at some date after the negotiation of the weapon system. Under the SAIP concept spare parts were ordered and prices negotiated at the same time as the weapon system, thus economies of scale should be realized. Detractors to this idea say that there is a potential for increased obsolescence when using SAIP procedures. This research evaluated orders placed for SAIP items and non-SAIP items to determine whether or not the incidence of obsolescence was greater when utilizing SAIP procedures.

CHAPTER II

LITERATURE REVIEW

The SAIP concept did not originate within the Air Force. It has been a common practice in commercial industry for a number of years. The McDonnell Douglas Corporation may have been the first aerospace company to utilize SAIP acquisition procedures. McDonnell Douglas negotiated purchase options with their vendors and subcontractors to provide spare parts in quantities in excess of their initial provisioning requirements and at the same prices as the production installed parts (2).

The A-7 acquisition program was the first Air Force program to utilize SAIP type acquisition procedures, although it was not called SAIP and it was not specifically covered by any Air Force regulations. The acquisition program was administered through a series of contractual clauses negotiated with the prime contractor (4).

The A-7 contract had a clause to protect the government from buying obsolete spare parts. According to this provision of the contract, if an engineering change was incorporated during a particular acquisition cycle, the production installed units and the initial provisioning spares had to be interchangeable or the spares were

deficient. A deficiency was defined as an item that was improperly configured (4).

The A-7 prime contractor was contractually responsible for providing properly configured spare parts, including those provided by its subcontractors. If spare parts were deficient, the prime contractor was responsible for replacing them with properly configured items at no further cost to the government.

The only test of these procedures on the A-7 program was when improperly configured spares, amounting to approximately two million dollars, were delivered to the Air Force. When the prime contractor notified the Air Force that they were willing to modify or exchange the improperly configured parts, the Air Force had only minor success in locating and returning the affected parts (4).

The first Air Force acquisition under the current SAIP concept was the F-15 program. When the prime contractor ordered subassemblies from its subcontractors in quantities in excess of its needs, the excess parts were offered to the Air Force at a significant cost savings. This demonstrated to the Air Force that concurrent ordering of initial and replenishment spare parts with production units could result in substantial savings (20).

Limited efforts have been put forth to determine whether or not SAIP procedures actually affect the design stability or cost of acquiring spares. The prime contractor

of the A-10 aircraft, the Fairchild Republic Company, evaluated 364 items delivered in support of the A-10 weapon system. When a check was made on the unit prices paid for items ordered using SAIP procedures versus items ordered not using SAIP procedures for identical spares, Fairchild reported that the average unit price paid for SAIP items was $3,314.33 as compared to an average unit price of $3,335.76 for non-SAIP items. The total contract savings for SAIP items was reported to be $1.3 million (7).

Air Force Regulation 800-26 indicates that the SAIP concept offers several advantages. First, acquiring spare parts using the SAIP concept holds down the cost of spares by avoiding the costs associated with separate material orders and manufacturing actions. Second, SAIP is used to improve pricing on spares orders. Third, SAIP buys should be made using firm fixed-price terms. If time does not allow negotiation of prices, not-to-exceed (NTE) price procedures may be used. If NTE procedures are used, Defense Acquisition Regulation (DAR) 4-300 should be used as a guide for negotiating a firm fixed-price contract (18:4-29). Finally, SAIP is used as a means by which to reduce the possibility of receiving spare parts that are not currently configured (16:2).

During an Inspector General inspection at HQ Air Force Logistics Command in March 1979, the implementation of the SAIP concept on the F-15, F-16, and A-10 programs

was found to be unsatisfactory (9). As a result of this finding, AFLC and AFSC jointly drafted a regulation to implement AFR 800-26. This draft regulation, once approved, will establish AFLC/AFSC policy, provide procedures and assign specific responsibilities for planning and implementing the SAIP concept (14).

As stated earlier, the SAIP concept was originated to ultimately reduce costs and reduce the risk of obsolescence, thereby reducing the chance of buying supplies or equipment that were not of a stable design. SAIP was not visualized to be an all-encompassing concept. The requiring agency must also rely heavily on the contractor to furnish recommendations on type and quantity of spares required, to include requisite test data and estimated failure rate data (20).

In light of the foregoing, the prime contractor has the primary responsibility for developing the list of initial spares required to support the weapon system. The Air Force then screens the list to determine which items will be controlled through the use of SAIP procedures. The items selected for SAIP should be considered to have a significant impact on the total cost of the system. SAIP procedures are to be used in each new production program estimated to cost $300 million or more and any modification program estimated to cost $100 million or more which requires initial spares support. Additionally,

the Commanders, Air Force Systems Command and Air Force Logistics Command, may designate that any other program or project acquisition requirement be accomplished using SAIP procedures, regardless of dollar value.

> Ideally, the SAIP items selected should comprise only from 10 to 15 percent of the total initial spares, but should represent a large share of the initial spares investment (from 65 to 75 percent). This provides intensive management of the most significant cost-driving spares to be acquired.
>
> The list should be of a manageable size that can be successfully acted upon within the time and manpower constraints of both the contractor and the Air Force [16:1].

SAIP procedures dictate that a contractor's list of recommended SAIP items should be provided to the Air Force 120 to 180 days prior to the order date to allow the Air Force adequate time for review and acceptance. The list is to contain an estimate of the percent of total spares and total spares investment along with the rationale used in making the selection. If the contractor orders spares using the SAIP concept, the pricing of items for production installation and spares must be consistent and uniform (16:2).

Changes to SAIP spare parts are concurrent with changes to the end article item. Order quantities are stable unless a major program change occurs. Order quantities are computed using the logic in AFLCR 57-27; however, initial SAIP procurements are based on the program related to fiscal year end-article deliveries rather than deliveries through the total item support period. This

requires yearly initial SAIP procurements until the total initial requirements are procured and the item is phased into the replenishment requirements system, or when the item is deleted from the SAIP program (13:1-7).

The requirements for application of SAIP procedures on the A-10 program differed somewhat from those specified in AFR 800-26. Personnel in the field believe that the overriding requirement for the application of SAIP procedures on the A-10 program was its potential for cost savings. Little or no regard for design stability or effect on obsolescence was considered. Spares affected by design changes were produced on a proportionate basis with items for production installation (6).

In an interview with the Administrative Contracting Officer (ACO) for spares on the A-10 program, the following general information was received concerning the application of SAIP procedures on spares acquisition (6). Spares requirements for SAIP parts were not determined with different procedures than for non-SAIP parts. The quantity determination for SAIP parts was not different than for non-SAIP but the order dates were different because SAIP quantities were determined and ordered from the prime contractor prior to execution of the production contract. Non-SAIP spares were ordered disregarding the prime contractor's production schedule.

Approved engineering change proposals (ECPs) affected SAIP spares because SAIP spares had to conform with the ECP. Delivered SAIP spares having approved ECPs processed against them were not subject to different procedures than those governing delivered spares orders under non-SAIP procedures.

The A-10 Principal Contracting Officer, formerly called Procuring Contracting Officer (PCO), responded differently than the ACO when he was asked if older systems spares were updated to insure interchangeability with spares having later configurations (8). The PCO stated that systems were modified and the spares were configured to the modified version. The ACO stated that spares ordered in line with production units were configured to match production installed parts but that spares ordered not using SAIP procedures were configured to accommodate the earlier models. Both the ACO and PCO agreed that the manufacturer had no obligation to modify or replace improperly configured spares at no expense to the government.

The primary purpose of Air Force Logistics Command (AFLC) Regulation 57-27 is to establish guidelines aimed at achieving maximum initial support with available resources (13:1-1). Emphasis is placed on acquiring spare and repair parts with a reduction in supply response time to allow for a minimum but adequate range and depth of

their stockage. In order to insure that spares are economically acquired, AFLC requires that all acquisition programs must consider the design stability of a system and its impact on logistics costs and risks as well as operational factors in planning the initial phase-in of operation capability and logistics support.

The prime contractor believes that buying spare parts under SAIP procedures increased the risk of obsolescent, but feels that the benefits derived by the Air Force in cost savings by aligning spare requirements with production schedules offset the adverse affects of increased obsolescence. They had not studied the problem of obsolescent and only offered their opinion (1).

CHAPTER III

RESEARCH METHODOLOGY

Overview

The objective of this research was to determine if the incidence of obsolescence was greater for spare parts ordered under SAIP procedures than for those ordered not using SAIP procedures. Since there was no direct measure of obsolescence, an indication of obsolescence was measured by determining the number of government approved Class I Engineering Change Proposals (ECPs).

Operational Definitions

Obsolete spare parts are those parts which are, because of a design change, rendered unusable in their present configuration to perform their intended function. Obsolete parts may be either scrapped or modified to bring them into a usable configuration. A design change which affects form, fit, or function is the means of creating obsolete parts.

An ECP is a formal proposal to alter the physical or functional characteristics of the system or item after the baseline configuration has been established (19:42).

ECPs have been categorized into two types: Class I and Class II. ECPs are classified as Class I, according

to MIL-STD-480 (19:2-3), when one or more of the following factors are affected:

1. Functional configuration identification.

2. Product configuration identification.

3. Technical requirements (maintainability, reliability, weight, performance, etc.) which are below product identification.

4. Nontechnical contractual provisions (cost, schedules, guarantees, etc.).

5. Other factors such as safety, compatibility with test equipment, interchangeability, suitability or replaceability.

Class II ECPs are documentary only (e.g., correction of errors or additions of clarifying notes) or a change in hardware which does not affect factors listed in Class I ECPs (e.g., material substitution) (19:2-3).

ECPs are submitted by the contractor to the government for approval. ECPs may be initiated by the contractor or as directed by the government. For the purposes of this research, no distinction was made as to whether an ECP was initiated by the contractor or the government. Likewise, no distinction was made as to the purpose of the ECP, e.g., the purpose could be to correct a deficiency or it could be to add a new capability or make an improvement. The reason for not making these distinctions was that

these conditions have no bearing on whether or not an ECP creates obsolete parts.

Method of Measurement

A major problem encountered in researching obsolescence was determining how to measure obsolescence. If one were interested in measuring the length of a board, it would be a simple matter to use a rule to determine the length of the board in feet or inches. With obsolescence, however, there is no accepted measuring instrument such as a rule and no direct unit of measure such as feet or inches. These facts made it clear that this research would have to measure an indication of obsolescence rather than directly measuring obsolescence.

Design stable parts are parts which are not subjected to design changes. Obsolete parts are the result of a design change. Design instability results when design changes take place. Air Force Regulation 800-26, Spares Acquisition Integrated with Production (SAIP), indicates that obsolescence created by an unstable design will be minimized (16:1). From this it can be interpreted that parts ordered under SAIP procedures should be design stable. It seemed reasonable, therefore, that an indication of obsolescence could be measured by measuring the design stability of a spare part. The best indication of the design stability of a spare part was the number of approved

Class I ECPs that had been issued against that part. Therefore, this study measured an indication of obsolescence by measuring the number of approved Class I ECPs issued against a part.

Another major decision which had to be made was over what time period to measure obsolescence. At the time of this study, there had occurred nine major spare parts orders or options on the A-10 program. It had to be decided whether to concentrate on a particular order such as one of the early orders or to consider all the orders combined when selecting the samples. The argument for concentrating on a particular order such as one of the earlier ones, was that in the early phases of the production run, parts were less design stable because the flaws or bugs had not yet been eliminated. A decision was made to consider all of the orders when selecting our samples, because SAIP procedures had been used on all of the orders and thus a clearer picture of the effects of SAIP would be presented. To concentrate on the early orders would mean that conclusions could only be made about these early orders and not about the entire program.

Description of the Universe

Generally speaking, SAIP acquisition procedures have been used to support the F-15, F-16 and the A-10 weapon systems; however, this research investigated the

A-10 program only. Therefore, the universe of interest was all spare parts required to support the A-10 program. Justification for the study of the A-10 spares program was the fact that the Air Force had utilized SAIP procedures for the acquisition of large quantities of spare parts to support the A-10 system and sufficient data were available for analysis (9). Spare parts for the A-10 program have been purchased since 1975 using SAIP procedures. Thus, data listings, such as those described below in the data collection plan, were readily available from the prime contractor.

SAIP procedures have been used on both the F-15 and F-16 programs, but the procedures have not been used as extensively on these programs as on the A-10 program and, as a result, insufficient data were available for analysis.

Description of Population

The two populations of interest consisted of A-10 spare parts ordered utilizing SAIP procedures and A-10 spare parts ordered not utilizing SAIP procedures. Only spare parts with a unit price in excess of $200 were considered in the two populations. This assured that small "nuts and bolts" type of parts were not compared with larger more complex parts which may have been more susceptible to design changes. This $200 limitation did not reduce the size of the SAIP population since all of the

SAIP items were priced at more than $200, although some were in the $200 to $300 range. The $200 limitation did cause a considerable reduction in the size of the non-SAIP population. The size of the non-SAIP population, minus the parts priced less than $200, was still considerably larger than the SAIP population.

Data Collection Plan

A SAIP spare parts listing which showed the part numbers, prices and definitized order numbers for all A-10 spare parts ordered under SAIP procedures was obtained from the Fairchild Republic Company (7). This listing was prepared by Fairchild at the request of and for use by the Air Force Logistics Command. From this listing, the random sample of SAIP parts was drawn. The sample of non-SAIP parts was randomly selected from the definitized spare parts orders placed under contract F33657-75-C-0228, the A-10 spare parts contract (12). A second parts listing obtained from the Fairchild Republic Company, the Integrated Logistic DCN list, showed all of the A-10 spare part numbers and their applicable approved Class I ECPs (5). This listing was used to determine the number of approved Class I ECPs issued against the part numbers selected in the two random samples.

The two random samples were selected as described above. Each part number in the two samples was then

checked in the Integrated Logistic DCN listing to determine the number of approved Class I ECPs. This data was used as the input data for the statistical test described below.

Sampling Plan

A sampling plan was chosen rather than a census because of the difficulty and length of time involved in taking a census. There was enough similarity among the parts in the populations that a few of these parts adequately represented the characteristics of the total population (3:135).

Two independent random samples were selected for the statistical test of the populations. A random sample of 35 part numbers was selected from each of the two populations. The sample sizes were chosen arbitrarily since there was no basis for estimating the sample or population standard deviations which would be needed to statistically calculate an appropriate sample size (3:149). Sample sizes larger than 20 are considered large for the Mann-Whitney U test and with large sample sizes, the z statistic is approximately normally distributed with a mean of zero and a variance of one (11:120).

The population of SAIP parts consisted of 364 different part numbers. The number of part numbers in the non-SAIP population was approximately 1,000, excluding those priced less than $200.

The prices of the parts in the SAIP sample ranged from $223 to $8,313 and the arithmetic mean was $1,846. For the non-SAIP sample, the prices ranged from $289 to $6,470 and the arithmetic mean was $1,748.

The parameter which was measured in the two samples was the number of approved Class I ECPs for each part number. The data measured are listed in Appendix A.

Statistical Test

The objective of the statistical test was to determine if the population of SAIP parts had more approved Class I ECPs than the population of non-SAIP parts for the A-10 aircraft. The independent variables used were the procedures under which the spare parts were procured, i.e., non-SAIP buys (sample 1) and SAIP buys (sample 2). The dependent variable used was the number of approved Class I ECPs for the part numbers selected in the two samples.

After the independent random samples were selected and the number of approved Class I ECPs for each selected part number had been determined, a one-tailed Mann-Whitney U test was performed to determine if the SAIP population had a larger mean number of approved Class I ECPs than the non-SAIP population.

The Mann-Whitney U test is a nonparametric procedure used to determine if two populations of the same

shape differ in location. The test required three assumptions. The first assumption was that the two population distributions had the same shape but no assumption as to what that shape was. The second assumption was that the data were at least ordinal. The final assumption was that the data represented a distribution which had underlying continuity (10:370).

Since the SAIP and non-SAIP populations were both drawn from the same universe of A-10 spare parts, it was assumed that they had similarly shaped distributions, although the exact shape of their distribution was not known. The requirement for at least ordinal data was clearly satisfied by the measured data of this research.

The data gathered for this research clearly came from a distribution of discrete data which has numerous ties rather than a continuous distribution. With continuous data, the probability of tied scores when measuring data is zero. To overcome this problem, the Statistical Package for the Social Sciences (SPSS) computer program which was used to compute the Mann-Whitney U test utilizes Siegel's correction factor for numerous ties and this caused no degradation in the power or accuracy of the results (11:23).

The Mann-Whitney U test was chosen over the more powerful parametric test, the t test, because the exact shape of the population distribution was not known. The

Mann-Whitney U test did not require knowledge of the shape of the underlying distribution. The Mann-Whitney U test, however, is an excellent alternative to the t test, its power efficiency approaches 95.5 percent as the combined sample size increases and is close to 95 percent for moderate-sized samples (11:126).

Test Parameters

A. Statistical Hypothesis

H_0: The number of approved Class I ECPs for SAIP parts $\leq$ number of approved Class I ECPs for non-SAIP parts.

H_1: The number of approved Class I ECPs for SAIP parts > number of approved Class I ECPs for non-SAIP parts.

B. Significance Level

$\alpha = .05$ (one-tailed test). This represents the risk of concluding H_0 when H_1 is correct.

C. Rejection Region

Since H_1 predicted the direction of the difference, the rejection region was one-tailed. It consisted of all values of z, the standard normal variable, which were such that the probability of obtaining those z values under the conditions of H_1 was greater than $\alpha = .05$. Thus, if the probability of obtaining the calculated z value was greater than $\alpha = .05$, H_1 would be rejected. Conversely, if the

probability of obtaining the calculated z value was equal to or less than $\alpha = .05$, H_1 would be accepted.

D. Decision (see Appendix B for the SPSS program and Appendix C for the SPSS output)

The SPSS computer program listed in Appendix B was used to calculate the Mann-Whitney U test. The results of the Mann-Whitney U test are listed in Appendix C.

The calculated z value, using Siegel's correction factor for ties, was -0.396 and its associated two-tailed probability was 0.692. The two-tailed probability was divided by two to get the required one-tailed probability, 0.346. Since the one-tailed probability of 0.346 was greater than $\alpha = .05$, the calculated z value was in the rejection region and consequently H_1 was rejected. To accept H_1 would have required a one-tailed probability of .05 or less which would have been possible only if the z value was ≥ 1.645 or ≤ -1.645.

Thus, when tested at the 95 percent confidence level, we could not conclude that the number of approved Class I ECPs for SAIP parts was significantly greater than the number of approved Class I ECPs for non-SAIP parts.

Summary of Assumptions

The assumptions that have been made are:

1. There was no direct measure of obsolescence but it has been assumed that measuring the quantity of

approved Class I ECPs was a valid indication of obsolescence.

2. In order to apply the Mann-Whitney U test, it was required that the assumption be made that the shape of the two populations under investigation was the same, although the exact shape of the distributions was unknown.

3. The sample sizes were chosen arbitrarily because of a lack of knowledge about the population parameters. It was assumed that the sample sizes chosen were adequate to make the necessary statistical inferences about the underlying populations.

4. It was assumed that the data were accurate and complete.

5. It was assumed that the samples selected were truly representative of the populations of spare parts from which they were drawn.

Summary of Limitations

The limitations of this research are:

1. Although SAIP spare parts ordering procedures have been applied on the F-15, F-16 and A-10 programs, this study was limited to only the A-10 program due to insufficient data on the other two programs.

2. This study only considered whether the risk of obsolescence is increased when SAIP procedures are applied and does not address the problem of the costs involved with obsolescence.

CHAPTER IV

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter presents a summary of what has been accomplished by the research. The conclusions are presented along with some possible explanations for the results. The final section contains three recommendations for further research.

Summary

The objective of this project was to determine if utilizing SAIP acquisition procedures to buy spares in advance of need and in larger quantities than demand indicates is optimal has an affect on the incidence of obsolescence on those spares. No feasible method of directly measuring obsolescence was found; it was decided to indirectly measure it by using a surrogate.

Engineering changes are the vehicle by which parts are made obsolete. It was decided to use the number of approved Class I ECPs as an indication of obsolescence.

The A-10 system was chosen for study because of the extensive use of SAIP during its acquisition and the ready availability of data.

Random samples of SAIP parts and non-SAIP parts were compared using the Mann-Whitney U test to determine if the SAIP population of parts had a larger mean number of approved Class I ECPs than the non-SAIP population. A one-tailed test was conducted at the 95 percent confidence level.

The test results did not indicate that the SAIP population of spare parts had a significantly greater number of approved Class I ECPs than the non-SAIP population of parts.

Conclusions

The results of the Mann-Whitney U test indicated that the number of approved Class I ECPs for the SAIP population of parts was not significantly greater than for the non-SAIP population of parts. This means that the SAIP population of parts was not significantly less design stable than the non-SAIP population. Therefore, the investigators concluded that on the A-10 program, using SAIP acquisition procedures to buy spare parts had not increased the incidence of obsolescence.

The reasons are not clear as to why obsolescence is not significantly greater for the SAIP population of parts. Ordering spares in advance of need and in larger quantities than demanded should offer the opportunity for buying spares which will become obsolete. This idea was

reinforced by the fact that design stability has received little consideration on the A-10 program when ordering spare parts using SAIP procedures.

There are several possible explanations as to why obsolescence on A-10 SAIP parts was not greater than on non-SAIP parts. The authors suggest five possible explanations. The first is that, by sheer chance, the parts selected for SAIP acquisitions were at least as design stable as the non-SAIP parts. The next possible explanation is that the A-10 aircraft was generally design stable and experienced relatively few design changes over all parts. The third possible explanation is that the type of parts typically selected for purchase under SAIP procedures was inherently design stable and required little management attention. The fourth possible explanation is that ECPs, unless absolutely essential, were not approved by the Air Force when large quantities of affected spares were in stock. The final explanation offered is that there was a combination of factors which interacted to cause the results.

The authors do not promote any of these explanations or any other explanations which could explain the results of this research. They are offered only as possible causes. The research did not address the questions of why ECPs were submitted or why they were approved.

Furthermore, the rationale for buying parts under SAIP procedures rather than non-SAIP was not addressed.

The only conclusion which can be drawn from this research is that the incidence of obsolescence on A-10 spare parts ordered under SAIP procedures did not appear to be greater than for those parts ordered not using SAIP procedures.

Recommendations

The authors believe that three areas need further research. First, the incidence of obsolescence on a SAIP program should be compared with the incidence of obsolescence on a program which did not use the SAIP concept. The results of a between-program study could be compared with the results of this within-program research.

The second recommendation concerns costs. The A-10 prime contractor claimed costs savings for the Air Force of $1.3 million by using SAIP acquisition procedures. These costs savings are assumed to be on initial costs rather than ownership costs which include initial costs, storage costs, handling costs and other costs associated with operating and supporting the end item. The authors recommend that the cost effectiveness of the SAIP concept be studied and that total ownership costs be included rather than just initial costs.

The final area recommended for further study concerns the implementation of SAIP procedures on the A-10 program. It was reported by field representatives that some aspects of AFR 800-26 have not been implemented on the A-10 program. Little or no regard for design stability or effect on obsolescence has been considered. Furthermore, items priced as low as $200 have been purchased using SAIP procedures. It is recommended that this area be studied to determine to what extent AFR 800-26 has been implemented. A decision needs to be made as to whether AFR 800-26 should be fully implemented or revised to bring it in line with the field application.

APPENDICES

APPENDIX A

SAMPLE DATA

Sample 1 (Non-SAIP)

Item	Manufacturer's Part Number	# ECPs
1	R48591	1
2	V68400-01	1
3	0711288-101	0
4	0711289-003	0
5	160D145277-11	1
6	1211157-104	1
7	160D637161-R1	0
8	160D965020-1	1
9	160D115009-23	0
10	160D120140-1	1
11	160D612416-12	1
12	160D323010-1	1
13	160D180435-3	2
14	1618T100-17	0
15	160D145265-1	6
16	160D117113-4	1
17	160D612602-30	0
18	160D955409-5	0
19	160D145271-9	2
20	160D611532-R9	1
21	159846-01-01	1
22	102709	2
23	2733574	1

Item	Manufacturer's Part Number	# ECPs
24	2753424	0
25	2753292-101	1
26	3846016-1	0
27	34350-9A	3
28	34150-9A	0
29	65104-04	1
30	751C054-401	1
31	757523-1	1
32	7310029	1
33	741C028-1	1
34	883-7201-000-05	0
35	883-6201-000-07	0
	TOTAL	33

Sample 2 (SAIP)

Item	Manufacturer's Part Number	# ECPs
1	A4526110001	1
2	HP1118610-5	0
3	HP960400-7	0
4	0711294-003	1
5	156130-10	1
6	1603T100-1	0
7	19063-1	1
8	160D712170-1	1
9	1601037-03	0
10	1601024-11	0
11	1211162-003	0
12	2730621	1
13	2730534-1	1
14	292E795G2	2
15	2327-1-26	1
16	292E794G2	2
17	2327-1-27	1
18	2730551-5	0
19	2F1-6-40930-11	2
20	3826032-1	0
21	34363-9A	2
22	34140-9B	1
23	43051-440	1

Item	Manufacturer's Part Number	# ECPs
24	43051-011	1
25	519892-2-2	0
26	712633C	1
27	797016-1	1
28	80688-3	0
29	80784-3	0
30	8DJ215WAD1	1
31	80782-3	1
32	80678-1	1
33	883-2402-030-03	0
34	883-2408-030-03	0
35	977J036-1	1
	TOTAL	26

APPENDIX B

SPSS PROGRAM FOR MANN-WHITNEY U TEST

SPSS Program

```
1000NNS,R(SJ) :,8,16;;,16
1005$:IDENT:WP1186,AFIT/ROBERT ARTHUR
1010$:SELECT:SPSS/SPSS
1015RUN NAME;MANN-WHITNEY TEST,MENDENHALL(P. 498)
1020VARIABLE LIST;NAR,GROUP
1025N OF CASES;70
1030INPUT FORMAT;FREEFIELD
1035NPAR TESTS;M-W = NAR BY GROUP(1,2)
1040READ INPUT D TA
1045$:SELECTA:BOBA19,R
1050FINISH
99993:ENDJOB

ready

*LIST
```

Input Data

Sample 1 (non-SAIP)			Sample 2 (SAIP)		
100	1	1	200	1	2
101	1	1	201	0	2
102	0	1	202	0	2
103	0	1	203	1	2
104	1	1	204	1	2
105	1	1	205	0	2
106	0	1	206	1	2
107	1	1	207	1	2
108	0	1	208	0	2
109	1	1	209	0	2
110	1	1	210	0	2
111	1	1	211	1	2
112	2	1	212	1	2
113	0	1	213	2	2
114	6	1	214	1	2
115	1	1	215	2	2
116	0	1	216	1	2
117	0	1	217	0	2
118	2	1	218	2	2
119	1	1	219	0	2
120	1	1	220	2	2
121	2	1	221	1	2
122	1	1	222	1	2
123	0	1	223	1	2
124	1	1	224	0	2
125	0	1	225	1	2
126	3	1	226	1	2
127	0	1	227	0	2
128	1	1	228	0	2
129	1	1	229	1	2
130	1	1	230	1	2
131	1	1	231	1	2
132	1	1	232	0	2
133	0	1	233	0	2
134	0	1	234	1	2

APPENDIX C

SPSS OUTPUT FOR MANN-WHITNEY U TEST

MANN-WHITNEY TEST,MENDENHALL(P. 498)
04/21/80 PAGE 2

FILE NONAME (CREATION DATE = 04/21/80)

- - - - - MANN-WHITNEY U TEST

NAR
BY GROUP

GROUP =	1	GROUP =	2	
MEAN RANK	NUMBER	MEAN RANK	NUMBER	U
36.37	35	34.63	35	582.0

Z*	2-TAILED P
-0.396	0.692

*z value is calculated using Siegel's correction factor for numerous ties (11:123).

APPENDIX D

LIST OF ACRONYMS

ACO	Administrative Contracting Officer
AFLC	Air Force Logistics Command
AFLCR	Air Force Logistics Command Regulation
AFR	Air Force Regulation
AFSC	Air Force Systems Command
ECP	Engineering Change Proposal
Non-SAIP	Spares Ordered Not Utilizing SAIP Procedures
NTE	Not-To-Exceed
PCO	Principal (Procuring) Contracting Officer
PP	Procurement Plan
RFP	Request For Proposal
SAIP	Spares Acquisition Integrated With Production
SPSS	Statistical Package for the Social Sciences
USAF	United States Air Force

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